CESI Energy Journal

Issue 03 - April 2014

2030: New European Energy and Climate Framework

José Manuel Barroso presents the new European energy policy

Saudi Arabia: a soaring plan for growth

A double interview with Ahmed al Mubarak and Gianluca Marini

The Indian giant: seeking growth among contradictions

To realise its full potential India must tackle inefficiencies

03

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Issue 03 - April 2014

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Editorial

Salvatore Machì - Chairman, CESI
Matteo Codazzi - CEO, CESI

Trying to identify a trend in the evolution of the energy landscape is both risky and fascinating. We know what the main drivers are and the scope of the challenge – on the one hand the ever-increasing demand for energy and on the other an ecosystem, our planet, that must be preserved. But how should we manage these opposing sides and how can we work in a way that promotes sustainable development?

In this issue of EJ, we tell the story of some of the most ambitious projects and most dynamic situations to show how the energy industry is trying to respond to this challenge. Saudi Arabia has launched a radical reform of its energy system; in Europe pan-European e-highways are being developed with Germany, as often happens, trailblazing by restructuring its network while focusing on three HVDC corridors; and India is seeking to meet the challenge of universal energy access by renewing its infrastructure and regulatory framework.

These are signs that clearly indicate that the electricity sector is the engine of the economic growth and transformation. The protagonists of the revolutions we describe are renewables, networks and the integration of infrastructure and policies.

The production of energy from renewable sources is now an essential piece of the energy mix of each country and international policies. Scientific and technological progress enables us to exploit these sources of energy efficiently and effectively.

Storage and networks are the technological testing ground. On this front, an ever-more widespread and concrete collaboration between industrialized and developing countries is crucial. The sharing of technological know-how together with the experimentation of new technology and the implementation of highly innovative projects can lead to a rapid attainment of sustainable growth in developing countries.

Today the stumbling block is the integration of national policies that would make it possible for electricity to travel and flow through national borders and intercontinental boundaries with clear and stable trading and pricing rules. This is the area where progress is slowest. A prime example is Latin America, which has extraordinary potential that remains largely untapped due to the lack of a common policy and a true integration of energy systems and grids. As Nicolás Depetris Chauvin explains in the interview published in this edition of EJ, "energy integration… requires large capital investments, which is not abundantly available, but more importantly it requires the political will to undertake such a long-term commitment between countries. Currently, with the different political orientations on the continent, that seems to be something far off on the horizon."

How to make progress then? The best way to promote a change in policy is to simulate the different results of alternative choices. One must bring to the policy makers precise forecasts that make evident the benefits and the costs that lie hidden behind the most difficult choices. This is CESI's mission: it is our job, our commitment.
Enjoy the reading.

ENERGY IS THE ENGINE OF ECONOMIC GROWTH

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| TOP STORIES |

2030: New European Energy and Climate Framework

José Manuel Durão Barroso, President of the European Commission

2020 IS GETTING CLOSER AND EUROPE NEEDS TO PREPARE FOR 2030.
IN THE NEW ENERGY AND CLIMATE FRAMEWORK, THE EUROPEAN COMMISSION DEFINES NEW TARGETS FOR RENEWABLES AND GREENHOUSE GAS EMISSIONS.
THE PACKAGE PRESENTED IN JANUARY 2014 IS NOT JUST ABOUT NUMERICAL TARGETS, IT MEANS COMPLETING THE INTERNAL EU ENERGY MARKET FOR BOTH ELECTRICITY AND GAS. AN AMBITIOUS BUT REALISTIC PROGRAMME THAT WILL SHAPE THE GLOBAL DEBATE ON ENERGY AND CLIMATE.

Today we have agreed on the long-term direction for our energy and climate change policy.

We show how the European Union's leadership in global climate action is beyond doubt and we show that we can do this in a way that is beneficial for the economy. An ambitious and smart "2030 strategy" will contribute to Europe's share in global climate action, but will also help to reduce our costly dependency on import of gas and oil, boost our green technology industry and sustainable growth by providing a stable long-term perspective for our companies to invest.

So this "2030 proposal" is critically important. Climate change is a defining challenge of our time, while a truly European energy policy is key for our competitiveness. What we are presenting today is both ambitious and affordable. It shows that we are beyond the debate where you had to either be "green" or a defender of industry. We believe these two issues are not contradictory, but can perfectly go together if handled smartly.

Let me begin with the main headline figures. Since we are on track with our 2020 policies, we should build on them and go beyond. We are therefore proposing a binding 2030 greenhouse gas reduction target for the European Union of minus 40% (relative to 1990). That is ambitious, but feasible. 40% is the most cost-effective milestone on the 2050 road map for decarbonizing Europe's economy.

WE ARE PROPOSING A BINDING 2030 GREENHOUSE GAS REDUCTION TARGET FOR THE EUROPEAN UNION OF MINUS 40%

We also set a binding 2030 target for renewables at European Union-level. The goal is at least 27% of energy consumption. It is a function of the 40% target, because we can't reach the greenhouse gas target without a collective effort on renewables.
Having such a European Union renewables objective is also a very important signal to investors who need long-term certainty to make investments, and also a clear signal in terms of our security of supply. However, we

propose not to set national binding targets for renewables anymore, individually from Member State to Member State as we do now; because one lesson we have drawn from experience is that they risk the fragmentation of the internal market and do not allow us to reach the targets in the most cost effective way.
Here we will lead a bottom-up approach, leaving more flexibility to member states. They will work with us to make sure the national efforts add up to the European Union target. (…)

Member States remain free to set their own national renewables goals if they so wish; they can continue to support renewables, provided they remain within our state aid rules.
As you know, regarding the state aid rules, we are currently reviewing them to make sure there are no distortions. Because we have seen in the past that in some countries there were distortions precisely because of these national targets on renewables, including heavy subsidiarisation with sometimes important costs for competiveness and also creating distortion in terms of the internal market. (…)

THE COMPLETION OF THE INTERNAL ENERGY MARKET FOR BOTH ELECTRICITY AND GAS IS AN ESSENTIAL PART OF OUR APPROACH.

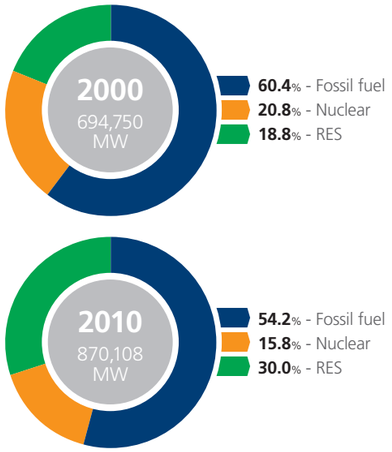
Of course, to deliver these targets we will need an overarching EU governance structure to ensure the delivery, maximise coherence, promote the integration of the European energy market, boost supply security and provide certainty to businesses.

There are first ideas for this in the package that we are now presenting. We will develop this in dialogue with Member States and it is wise to leave now some room for discussion. We want this package to be owned by all Europeans. We are now making the proposal, but at the end we need to have the support of the Member States and of course the European Parliament. After that debate, the Commission will make more detailed proposals. But our 2030 package is not just about numerical targets, even if they are extremely important.

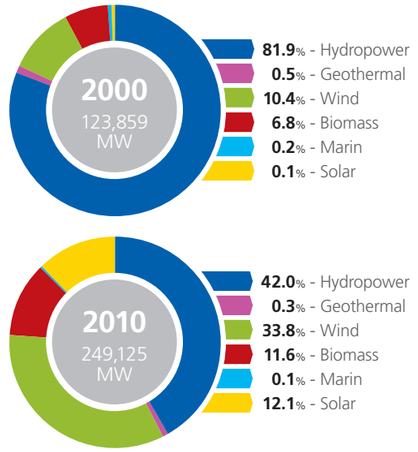
The completion of the internal energy market for both electricity and gas is essential part of our approach. It is estimated that a fully integrated and competitive market could result in cost savings of between 40 to 70 billion euro until 2030. Such progress cannot take place without a properly integrated, modern infrastructure.
That's why, as you know, we have also in the Multiannual Financial Framework proposed this Connecting Europe Facility and in fact we are doing everything we can to support Member States completing the infrastructure because this is one of the real problems we have that limits the possibilities of a true internal market.
Competition on energy markets must be enhanced through the development of energy transport infrastructure - including cross-border interconnectors, that may be more efficient in ensuring security of supply than support for domestic generation capacity. The agreed Projects of Common Interest under the Energy Infrastructure Regulation are an important step for Member States to meet the 10% level of interconnectors as a share of installed production capacity. The Commission will remain particularly engaged on this. (…)

Our package also deals with the Emissions Trading Scheme which is one of the keys to reaching our greenhouse gas reduction goals. Today we are tabling draft legislation amending the Emissions Trading Directive to tackle the supply-demand mismatch in the ETS. This will give predictability for the regime post 2020. To be clear on one point: we do not intend to change the market-based nature of the ETS - we want an automatic stabilizer. And even if only to be implemented afterwards we believe we should already now

Net power UE27



Renewable net power UE27



Sources: **GSE, "Statistical Report EU 27, Electrical Sector" (2012)**

make the legislative proposal, precisely for the reasons that I have mentioned, of certainty for investments.

And we are also dealing with the sensitive issue of shale gas. As you know, shale gas is now, in many ways, changing in a dramatic way the landscape of energy, at least in some parts of the world, also with very important consequences in terms of relative competitiveness. Today we are proposing a Communication and Recommendation on shale gas that balances the right of Member States to decide whether or not to exploit shale gas with the need to draw a Europe-wide baseline of environmental and safety rules. So this is an enabling framework on the basis of the existing *acquis*. This is not new legislation.
This is a good demonstration of the role that the European Union should play: setting the cross-border rules for the environment, health and safety, but not meddling in the basic energy mix that is to be chosen by Member States.

Finally, we are also publishing a detailed analysis of energy costs and their drivers, which contain very important, interesting and useful facts on the real reasons of rising EU energy costs, and on what we can do at the European level. We need to halt the constantly rising energy costs for households and business. Many factors are at play, but I want to see a serious effort made to make our energy as cost effective as possible. And you will see that a big part of the costs are the result of the fact that we don't have yet a really integrated internal energy market and that with very different policies of support from Member States this creates additional costs, not only on taxation, but also because of the fact that there is not for instance a proper interconnection.

THIS IS A GOOD DEMONSTRATION OF THE ROLE THAT THE EUROPEAN UNION SHOULD PLAY: SETTING THE CROSS-BORDER RULES FOR THE ENVIRONMENT, HEALTH AND SAFETY, BUT NOT MEDDLING IN THE BASIC ENERGY MIX THAT IS TO BE CHOSEN BY MEMBER STATES

Let me conclude on why we are doing this now. It is in everyone's interest that we provide predictability for investors, that we complete the internal energy market and that we tackle import dependency. This is our internal reason to act. 2020 is basically around the corner so we need already to prepare for 2030. (…)
We believe that this package for Climate and Energy is ambitious but realistic. And I am sure it will now launch the "2030 debate" among Member States, the European Parliament and stakeholders.

This text is the result of an accurate selection extracted from president Barroso's speech during the press conference in Bruxelles for presenting the Energy and Climate Framework (January 2014).
You can find the entire statement on European Commission's web site: http://europa.eu/rapid/press-release_SPEECH-14-50_en.htm

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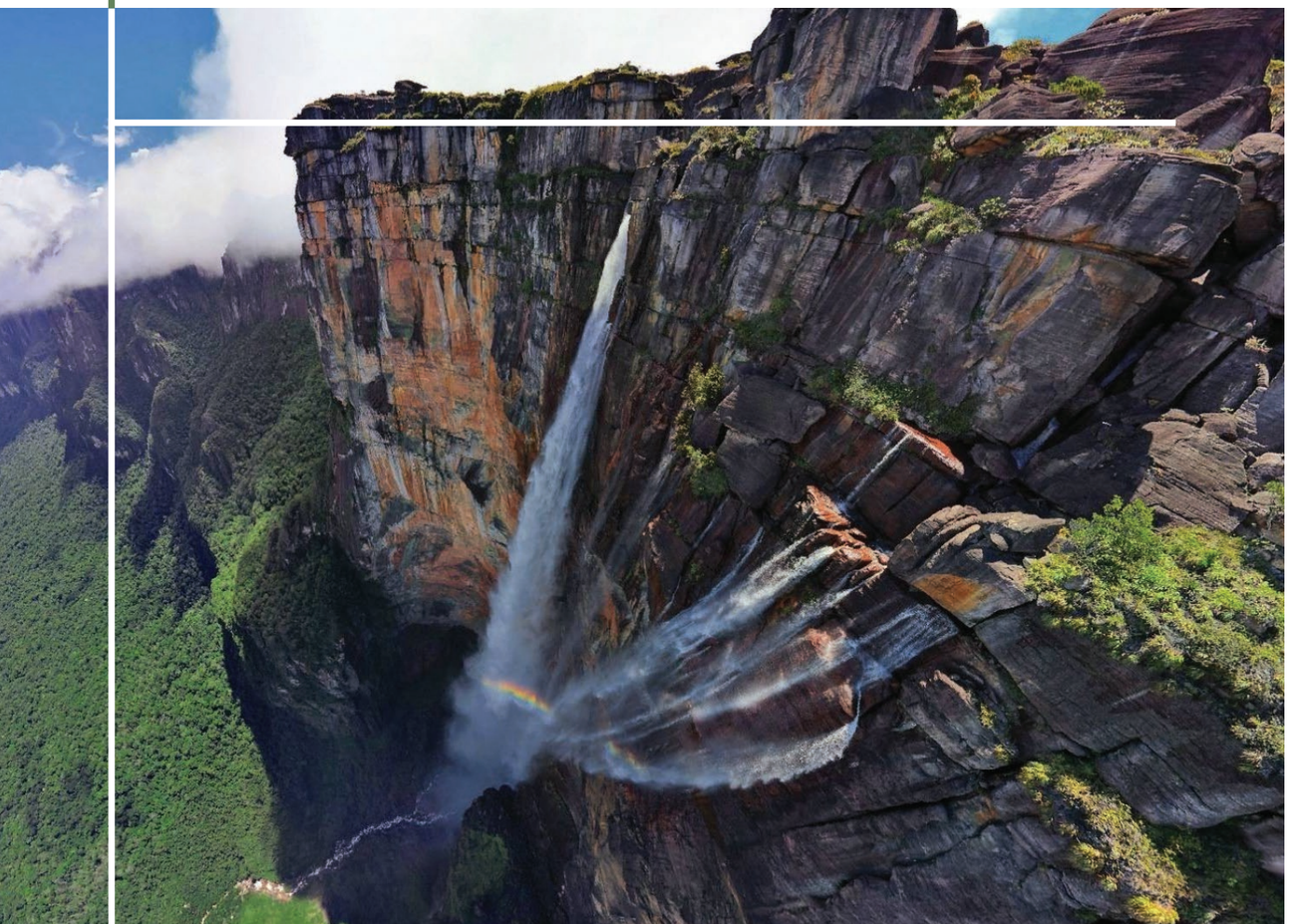
| INTERVIEW |

Strength in numbers: Latin America's energy potential

Interview with Nicolás Depetris Chauvin,
WEC's Regional Manager for Latin America

LATIN AMERICAN COUNTRIES ARE RICH IN ENERGY RESOURCES, BUT THIS WEALTH IS UNEVENLY DISTRIBUTED AMONG AND WITHIN COUNTRIES. SHARING A COMMON ENERGY POLICY AND DEFINING STRATEGIC PLANS FOR REGIONAL ENERGY INTEGRATION COULD INCREASE OVERALL ENERGY SECURITY. BUT THIS IS NOT AN EASY TASK.



When talking about Latin America, we are used to focusing our attention on Brazil and its dramatic economic growth. The country certainly has a leading role in the region, but each nation has its own particular profile. Could you briefly outline the energy profile of each country and the specific developing trends?

With twenty countries in Latin America, it would be hard to give a short outline of the energy profile and current trends in each of them so let me focus on the five largest countries Brazil, Mexico, Colombia, Argentina, and Venezuela.

Brazil is the largest energy consumer in LAC (8th largest in the world) and also the largest producer in the region (10th largest in the world). The recent story of the energy sector of Brazil is well known. Brazil transformed itself from an energy importer to an exporter and became the largest crude producer in Latin America. Despite this positive outcome, recent trends have been less optimistic. Most of Brazilian reserves are offshore and these wells are very expensive to develop.

Mexico has traditionally been an oil exporter to the United States. However, Mexico's oil fields reached maturity and its production has declined in recent years. At the same time, Mexico is a net importer of natural gas and its demand is rising due to greater use of the fuel for power generation.

Oil is the largest source of energy in Colombia, followed by hydroelectricity, natural gas, and coal. The country relies on hydropower for the bulk of its electricity needs and uses very little coal domestically. The country has important resources in small hydro, wind and solar energy but they are not well developed. One of the main challenges of the country is to bring electricity to rural areas where the coverage is well below the LAC average.

Argentina holds the world's second-largest reserves of shale gas and the fourth-largest of shale oil, according to U.S. Energy Information Administration data. The government has promoted a new deal aiming to improve the chances to get financing in international markets and foreign investments in the energy sector. This is very much needed, as the country had a record energy deficit of USD 6.1 billion in 2013.
Venezuela owns some of the largest oil and natural gas reserves in the world. It consistently ranks as one of the top suppliers of oil to the U.S. However, in recent years, Venezuela has attempted to diversify its crude oil export destinations away from the United States. Under the Petrocaribe initiative, Venezuela provides crude oil and refined products to numerous countries in the Caribbean and Central America.

LATIN AMERICAN COUNTRIES ARE RICH IN ENERGY RESOURCES, BUT THE LACK OF REGIONAL ENERGY INTEGRATION SLOWS DOWN REGIONAL DEVELOPMENT

The continent has an enviable abundance of raw materials, equally split between renewable and fossil fuels. Defining a common energy policy or a common strategy to face the great challenges these countries face would be helpful, but it does not seem to be an easy process. Where is the strongest resistance coming from?

Indeed, Latin American countries are rich in energy resources including hydrocarbons, hydroelectricity and biofuels. But this wealth is unevenly distributed among and within countries. However, as you noted, there is not a common energy policy in the region and this is part of a larger problem, the lack of regional energy integration. Regional energy integration is important to help neighboring countries to better distribute and commercialize their energy resources in order to reduce waste, protect against price volatility, lower transmission losses and increase overall energy security. There are important social benefits of international electric grid interconnection in the LAC region as it would improve reliability and quality of service, while allowing lower tariffs at the same time. Lower electricity rates, achieved through regional electricity cooperation and integration, will foster increased regional development. Energy integration of several countries with low electricity consumption could help achieve economies of scale.

However, regional energy integration is not an easy task. Besides the logistics, there is always the problem of politics as seen in the example of the gas Bolivia sells indirectly to Chile through Argentina. Because of the diplomatic and trade conflicts, countries in the region have always been playing with the tradeoff of energy autonomy and energy integration.

ENERGY INTEGRATION IN THE AREA WOULD REQUIRE POLITICAL WILL TO UNDERTAKE A LONG-TERM COMMITMENT BETWEEN COUNTRIES

There have been many projects looking towards integration but none of them has been successful so far. In gas there was the ambitious project of the 'Energy Ring', which involves bringing Peruvian gas to five countries. Another recent project, the Southern Gas Pipeline, is even more ambitious. Promoted by Venezuela, its other partners include Bolivia and the nations of Mercosur – Argentina, Brazil, Paraguay and Uruguay. In Mercosur there has been some progress in terms of energy integration but in hydro where there are several bi-national hydro electrical projects. Central America is a good example of energy integration with the Central American Electrical Interconnection System (SIEPAC). The SIEPAC consists of a 1,800-kilometer power transmission line with a capacity of 300 megawatts, sufficient to enable the creation of a regional electricity market.

So a short answer to your question would be energy integration, of which a common energy policy is only a part, requires large capital investments, which is not abundantly available, but more importantly it requires the political will to undertake such a long term commitment between countries. Currently, with the different political orientations on the continent, that seems to be something far off in the horizon.

Access to modern electricity is perhaps the most compelling issue these countries have to face in order to foster economic growth. Brazil launched the "Energy for All" program in 2003; the time for realising its targets has gradually been extended. What initiatives have been realized? Could it be replicated in other Latin American countries?

In Latin America between 40 and 50 million people lack access to modern electricity services, and fuel imports consume a growing percentage of smaller countries' budgets. However, we need to put this number in perspective. Those 40-50 million are 10% of the population and probably three quarters of them are in rural areas. In Africa 60% of the population does not have proper access to energy, in Asia it is 25%. Of course, in OECD countries, it is less than 1%.
Therefore I would say that Latin America is somewhere in between. Of course, I am not trying to downplay the problem. Access to energy is very important for the wellbeing of the population as it facilitates access to basic services such as education, health and communication, it allows access to information via television, computers, etc., and it allows for more and better social and productive activities.

For that reason governments and international organizations in the region have been seeking to increase energy coverage. The problem is that the marginal cost of providing energy increases with the level of coverage and in general the users who are in remote areas have low payment capacity. Basically the response from governments has been to implement rural electrification programs with a high subsidy component and for the users in more remote areas they have favored the use of off-grid technologies. The Brazilian Energy for All is an example of these ambitious programs, using other technologies besides the extension of conventional electrical grids, for example trough hybrid systems. While on a scale all its own, Brazil is not the only country in the region doing this. For instance, the Inter-American Development Bank launched in 2011 the LAC Sustainable Energy for All initiative and is supporting the UN's global initiative by funding work in the region.

Latin America is the world's green heart. Today, technological progress helps us defend the environment and promote sustainable development. Could you tell us something about the most interesting experience in Latin America from this perspective?

Latin America is a large and heterogeneous region where the institutional capacity to deliver energy policies and regulations which are key to economic growth and sustainable development vary greatly. Obviously, the institutional and regulatory framework matters a lot because to have the right incentives is key for innovation. There are several interesting experiences in LAC with respect to energy policies looking to promote sustainable development, but I think the most interesting one is Uruguay's energy policy. This policy was endorsed by the Multi-Party Energy Board of the Congress (so it is a state policy and not the policy of the ruling coalition) and set the policies for the sector until 2030, what for LAC standards is quite far into the future. The Energy Policy involves a strong commitment to diversification of the energy matrix and the incorporation of native energy resources, in particular renewable energies (the objective is that native renewable energy sources comprise 50% of the total primary energy matrix). The policy includes a legal framework and incentives for the development of wind energy, biomass, bioethanol, biodiesel, solar thermal, and small hydro plants. The policy does not look only to the supply side, but also focuses on demand by confronting important issues such as energy efficiency.

URUGUAY APPROVED ONE OF THE MOST INTERESTING ENERGY POLICIES REGARDING SUSTAINABLE DEVELOPMENT

The Uruguayan energy policy is an excellent example of a multidimensional and integrated vision – including technological, economic, geopolitical, environmental, cultural and social factors – that seeks to secure sustainable energy for the development of the country.

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| INDUSTRIES & COUNTRIES |

The Indian giant

Agnese Bertello
Alessandro Clerici, chairman 2000-2013 of the WEC study group "World Energy Resources"

WHILE AT A RELATIVELY SLOWER PACE, INDIA CONTINUES TO GROW. ENERGY CONSUMPTION DATA ARE THE MOST EVIDENT SIGN OF THE COUNTRY'S GROWTH. BUT THERE ARE STILL SOME BURDENS THAT PREVENT INDIA FROM REALISING ITS FULL POTENTIAL: THE COMPLEX CONSTITUTIONAL STRUCTURE AND THE POWER SYSTEM'S INEFFICIENCY ARE AMONG THEM.

The context

An area that covers 3.3 million square kilometres and a continually growing population of 1.2 billion people – these are India's credentials that best define the country's potential.

India is an emerging country that intends to push hard, and quickly, to escape this category to which up to now it has been relegated, but to do this it must confront its history and contradictions. Both have a direct impact on the energy system.
The government, institutions and the business world are now aware that the present rigid and complex constitutional structure is a burden that prevents the country from realising its full potential.

One of the most obvious contradictions that characterise India is certainly its demography: although in the last ten years the percentage of people living in urban areas has risen from 28% to 32%, those living in rural areas and working mostly in agriculture remain the majority. About 400 million people still do not have access to electricity.
The level of electrification goes from 97% in some states to 10% in others, for example Bihar.

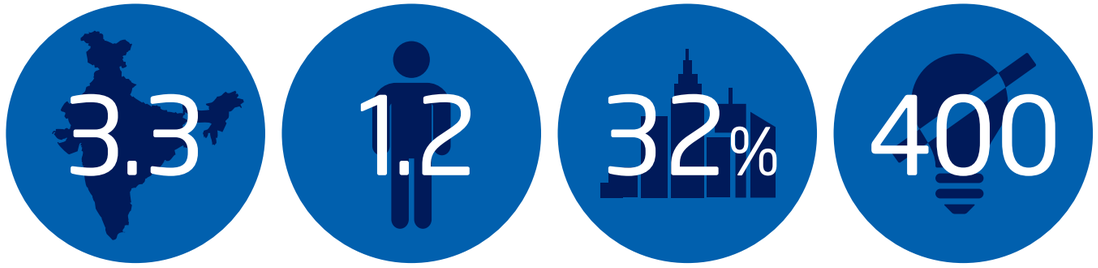
From an energy point of view, these aspects create some problems. On the one hand, rural communities are forced to use primary energy resources (30%) for survival and food production to feed the country, while on the other hand the high population density of the cities stresses the deficient electric system.
The electrical system's "non-technical" losses exceed 25% for the country and reaches 60% in some states.

THE INFRASTRUCTURE GAP IS AN EVIDENT BURDEN, NEVERTHELESS INDIA CONTINUES TO GROW INCREDIBLY QUICKLY

To the infrastructure gap one must add the institutional framework. Independent since 1947, the Union of India became a federal republic in 1950. Today the republic is composed of 28 strong states that enjoy a large amount of independence from the central government. It is a complex organisational structure with some inevitable inefficiencies.

Although these are critical factors, the country continues to grow incredibly quickly. The numbers tell the story, in particular those related to energy consumption.

| India in figures |



million square kilometres

billion people

people living in urban areas

million people still do not have access to electricity

The energy profile

Over the last five years, India has had one of the fastest growing economies in the world. The boom has greatly affected energy consumption, which has increased on average 8 -11% annually. The growth per year of gas consumption (10.5%) and oil (9.6%) has been particularly significant. The growth trend should, according to the provisions of the five-year plans (2012-2017 and 2017- 2022), lead by 2050 to India overtaking China, unofficial sparring partner in this race for growth.

THE ECONOMIC BOOM HAS GREATLY AFFECTED ENERGY CONSUMPTION, WHICH HAS INCREASED ON AVERAGE 8 - 11% ANNUALY

While India in 2011 in absolute terms had among the highest consumption of primary energy in the world (720 MTEP, third behind China and the United States), with regard to the annual per capita consumption the country comes in well below the middle of the ranking. Coal (59%) and oil (28%) cover more than four-fifths of primary energy consumption, far ahead of gas (9.8%), hydropower (5.3%), other renewables and nuclear.
It is an energy mix heavy on fossil fuels that is going to place India in the third position for CO_2 emissions behind the United States and China. Its carbon footprint (about 1.6 Gt/year) is expected to double in 2030.

Of the electrical system's 220 GW in operation at the end of 2012, two-thirds are fossil fuel plants (coal at 58% and gas at 9%) while large hydroelectric (above 25 MW each) 19%, renewables 12% and nuclear 2%.
Among renewable sources, wind is first with 18,321 MW of installed power (71% of the renewable total), followed by small hydro (power stations generating less than 25 MW), cogeneration, biomass and solar.

In terms of energy, 80% of the approximately 1000 TWh of electricity produced comes from thermal power plants, 12% from hydro, 3% from nuclear and 3% from wind. Less than 2% comes from other sources. Although in the last five years 55 GW (20 GW of which just in the last year) have come online, in 2012 the electrical system had a peak power output of 150 GW. While that is good growth, it does not hit the target set by the 2007-2012 five-year plan of additional 78 GW and comes up more than 10% short of entirely covering demand. The new XII five-year plan 2012-2017 calls for the entry into service of about 76 GW as the baseline scenario for conventional energy and 20 GW of renewables (50% wind, 33% solar, 9% biomass and 8% small hydro).

Of the 76 GW of "conventional" power in the baseline scenario, 63 are coal, 9.2 hydroelectric, 2.8 nuclear and 1 gas. A "high-gas" alternative scenario for the same period includes 12 GW of gas-fired plants instead of 1 GW.

In the following five years, according to the strategic plan, a further increase is foreseen with the coming online of another 93.5 GW of conventional plants to arrive in 2022 at a total of about 450 GW of which 20 from photovoltaic and 45 from wind. The private sector is expected to provide 57% of the total investment.

The development of renewables merits a separate discussion. While it is certainly true that the core of the expansion will be in fossil fuels, it is worth noting the efforts the country is making to open the way for green technology including a ministry dedicated exclusively to renewable energy sources. Other steps include collaborations and technological partnerships with western countries so as to be able immediately to apply the most innovative and efficient production technologies.

Among the alternative sources, the most promising is certainly wind, which, not coincidentally, is today the best performer.

The installed capacity in 2012 was 18 GW, making India the fifth largest market in the world in wind energy. But these results pale in comparison to the untapped potential in regions such as Karnataka, Rajasthan and Gujarat that is thought to be greater than 60%.

WHILE IT IS CERTAINLY TRUE THAT THE CORE OF THE EXPANSION WILL BE IN FOSSIL FUELS, IT IS WORTH NOTING THE EFFORTS THE COUNTRY IS MAKING TO PAVE THE WAY FOR GREEN TECHNOLOGY

Solar energy also has huge potential as India is located in one of the sunniest regions of the planet with a solar radiation (DNI) ranging from 4.5 in the south to 6 kWh/sq m/day in the north. Gujarat and Rajasthan, in the northern area, could produce 1,800 kWh / kW installed with conventional PV plants and as much as 2,200 kWh / kW installed with CPV (concentrated photovoltaic), which is a very interesting technology to be considered for these regions.

In the south of India (Karnataka) conventional PV can produce 1,500 kWh / kW installed. Though that is lower than in the north, it is around 1.5 times the world average making it extremely viable.

| A new laboratory for the Indian electrical grid's development |

As we have read, power sector in India is experiencing phenomenal growth. This calls for putting in place necessary transmission and distribution infrastructure so that power can reach consumers efficiently.
As the national grid adapts to an high-level of international standard, every single equipment must overtake a rigorous testing phase before being adopted.

Presently the existing test facilities available in India can handle short circuit testing of transformers up to 90 MVA. Due to the lack of short circuit testing facilities, large power transformers (especially 100 MVA and above) have been sent so far to overseas testing labs.

On the initiative of the Ministry of Power, the National High Power Test Laboratory (NHPTL), a Joint Venture among NTPC, NHPC, POWERGRID, DVC and CPRI has been incorporated to create a fully independent, stand-alone, state of the art, professionally managed and international class On Line High Power Short Circuit Test Facility in India. This facility will provide a full range of short circuit testing for the national and international power machinery and equipment manufacturers as well as national power utilities in conformity to Indian and International Standards.

Cesi has been appointed Technical Consultant of NHPTL. This is the last step of an enduring relationship between CESI and India started 30 years ago when CESI helped the Central Power Research Institute to build the National Laboratory for High Power Tests in Bangalore.

The development of nuclear power is a sensitive issue and the sector's development policy is managed directly by the prime minister. The Department of Atomic Energy (DAE) has confirmed a growth plan calling for dozens of GW through the creation of 10GW parks. With nuclear, however, the game is played mainly on the political and diplomatic fronts and the tragic events of Fukushima have had an important role in bringing to the fore the key issue of liabilities for large accidents. For investors, technology suppliers and local governments those liabilities are difficult to accept.

INTERVENTIONS IN THE ENERGY SECTOR ARE NOW A PRIORITY IN ORDER NOT TO COMPROMISE GROWTH

The grid

The electrical system is divided into five major subsystems: north, west, east, northeast and south. The latter works in an "asynchronous" manner compared with the other systems and is connected to the east and west with direct current (DC) connections.
The national transmission, PowerGrid, must interact with the ESCO of the 28 Indian states creating lengthy bureaucratic procedures in a country that has strong local opposition to new transmission lines, especially in densely populated area. In this clearly confusing framework, just obtaining a permit for the construction of a new line can become a challenge.

The Indian network is not connected with neighbouring countries and is as a sort of "power island". For this reason, among the projects being considered is the realisation of network interconnections with Nepal and Sri Lanka.
The XIII five-year plan (2017-2022) starts from the clear need to increase the capacity of existing lines and to move towards DC ±800 kV and AC 1,200 kV, a real world record. The same plan foresees the addition of 25,000 km of 765 kV AC circuits, 50,000 km of 400 kV AC circuits, 40,000 km of 220 kV AC and 6,000 km of UHVDC.

The implementation of these interventions would require more than 50 billion dollars in spending, accounting for 21% of all planned investments in the electricity sector.
To provide access to electricity in the most remote areas of the country, that are not connected to the national grid, the most effective method in the short term seems to be off-grid projects that are able to combine the use of the most innovative renewable energy technologies.
The possibility of carrying out experiments whit digital meters to improve the distribution system is under consideration. This could be a technology to be further implemented to facilitate, among other things, the reduction of non technical losses.

Energy Policy and Growth

The progress made by the Indian giant has been enormous, as we have seen.
Industrial growth and improvement of general living conditions, particularly in urban areas, have lead to an exponential growth in energy consumption. Intervening in the energy sector is now a priority in order to avoid compromising growth. This will mean above all better living conditions for the population, particularly in rural areas, that for high percentage still has no direct access to modern forms of energy.

Regulatory and policy action is necessary with regard to both technology and infrastructure. These actions must be combined with an environmental policy that aims to reduce emissions and defend the ecosystem. Imported gas and coal will remain India's main sources of energy with a resulting important effect on the balance of trade. The development of renewable energy – given the sector's high potential in both solar and wind – must be carried out using the most advanced technology available to ensure the country makes rapid steps forward but within cost effective approaches. For this reason, it is as strategic as ever for the future of the Indian subcontinent to have close and constant cooperation with western countries for a mutual exchange of technology.

Data quoted in this article have been presented and discussed during the 2013 World Energy Council in New Delhi.

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Designing a network, not a patchwork

Agnese Bertello
Domenico Villani, Director of Testing & Certification Division, CESI

THE EUROPEAN ROADMAP 2050 CALLS FOR A REDUCTION OF EMISSIONS OF GREENHOUSE GASES OF 80-95% COMPARED WITH 1990 LEVELS. AN AMBITIOUS GOAL THAT NECESSITATES AN EQUALLY MASSIVE DEVELOPMENT OF RENEWABLES AND TRANSMISSION AND DISTRIBUTION NETWORKS. WE ARE MOVING TOWARDS THE ERA OF THE E-HIGHWAY. GERMANY, WHICH IS NOW PLANNING THREE HVDC CORRIDORS, ONCE AGAIN TAKES THE LEAD IN EUROPE.

With the approval in 2009 of the 20-20-20 plan on climate change, the European Union clearly outlined its energy scenario. It was a clear choice that became clearer in 2011 with the drafting of the Roadmap 2050, which calls for a reduction of emissions of greenhouse gases of 80-95% compared with 1990 levels.

WE ARE USHERING IN THE ERA OF THE PAN-EUROPEAN E-HIGHWAYS THAT WILL RUN FROM NORTH TO SOUTH CROSSING EUROPE

The Roadmap 2050 is not limited to setting ever more ambitious goals for the production of energy from renewable resources and reducing CO_2 emissions, but also foresees the radical transformation of the energy market and system as a whole with an eye towards creating a true European single market for electricity. These are fundamental changes that call for a massive development of renewables while also calling for an equally massive development of transmission and distribution networks. One must connect in a quick, efficient and powerful way the opposite ends of this chain: production and consumption.

We are ushering in the era of the pan-European e-highways, of the electricity highways for the transportation of energy that will run from north to south crossing Europe without the need for passports.

Pan-European e-highway

In 2011, the European Union introduced the Energy Infrastructure Package, mandating ENTSO-E (the European Network of Transmission System Operators for Electricity) to develop a technical analysis to make a clear assessment of the needs of individual countries and the continent as a whole, identifying the key points of exchange and key corridors.

ENTSO-E is in a certain sense the "technical arm" of the European Commission. The network's task is to prepare accurate analysis on the needs of the market and outline possibilities for strategic development that are supported by extensive cost-benefit analysis. In 2012, ENTSO-E presented its Ten-Year Network Development Plan, a strategic document for the development of infrastructure networks. In particular, the TYNDP identified 100 specific projects and points of intervention.

Overall, it calls for the building or major restructuring of 52,300 kilometres of lines. Of these, 39,000 kilometres are in alternating current and 12,600 kilometres in HVDC direct current – overhead lines as well as underground and underwater cables. The planned investment is just over €100 billion.

According to ENTSO-E's estimates, the implementation of this program would lead to a cut in emissions of 170 Mt of CO_2. Expanding the network even only by 1.3% per year would make it possible to add 3% of extra renewable capacity or about 125 GW.

THE TEN YEAR NETWORK DEVOLOPMENT PLAN PRESENTED BY ENTSO-E CALLS FOR THE BUILDING OR MAJOR RESTRUCTURING OF 52,300 KILOMETRES OF LINES

Germany in the lead

Germany is once again at the head of this great new challenge. The Energiewende, the German energy transition program launched in 2011, foresees the closure of all nuclear power plants operating in the country by 2022 and sets decidedly challenging targets for energy production from renewable sources. While the 35% rate set for 2020 is pretty much a done deal, the goal for 2050 is set at 80%. The ambitious project requires strategic planning of German rigour so as to harness renewables' volatility.

At present, the main obstacle to the realisation of this project is the integration of renewable energy sources into the network. Jochen Homann, president of Bundesnetzagentur, the German regulatory authority for the electricity sector, affirmed as much at the opening of the Deutsch-Finnischer Energietag conference held in Berlin in late 2013. "The network is the Energiewende's bottleneck", said Homann.

Aware of the slow progress in the implementation of an infrastructure project of this magnitude, the previous Merkel government approved a law in 2011 to accelerate the planning process and approval of new transmission lines. The law has five distinct phases. It starts with the definition of the framework landscape, a document that identifies the country's actual consumption and the contribution of different energy sources over the arch of a decade. The Network Development Plan identifies the foreseen network corridors, the departure and arrival

| Putting technological innovation to the test |

The new CESI HVDC laboratory in Mannheim

CESI, with its German unit FGH Engineering & Test GmbH, brought its experience in Extra High Voltage Direct Current to Mannheim (Germany) creating one of the most important independent labs in the world to test HVDC systems, components and cables.

Technological innovation is without a doubt the most important weapon at our disposal to address the challenges in the energy sector. The transition from when research is carried out to the time of its application in the specific environmental context is among the most delicate moments in this sector where a mistake in the field can lead to significant economic losses and unacceptable network outages.

In an innovative sector such as High Voltage Direct Current where the standards are not yet fully defined, international experts get involved as do associations such as CIGRE (Conseil International des Grands Réseaux Électriques). Independent laboratories validate solutions and offer operators that introduce the solutions into their networks results that can be the benchmark for industry standards and a guarantee of stable performance over time.

The new CESI HVDC laboratory in Mannheim, closed to Frankfurt, will make it possible to carry out tests in three bays equipped with one-of-a-kind control and supervisory systems. The laboratory will also guarantee absolute privacy and secrecy of information of the data and knowledge management. In these bays it is possible to test cable systems of up to 1200kV in dc. Each cable system can be developed within the laboratory or towards the outside for up to 100 metres. Temperature and pressure controlled tests make it possible to verify the lifecycle of a cable by simulating its behaviour up to 40 years in the future in realistic environmental conditions such as sand, salt water and tunnels. At the laboratory it is also possible to do tests in polluted environmental conditions and to carry out mechanical and seismic tests for systems designed for critical areas.

TERNA, the Italian transmission operator (TSO) that is among the most active in the application of HVDC systems, has already built important interconnections with HVDC cables between Italy and the Greek peninsula, Sardinia and Corsica and it is implementing new interconnections to France and to Montenegro.

In CESI's Mannheim laboratory, Terna launched a qualification plan with unique comparative tests on HVDC cable systems to verify the actual endurance of the polarity inversion on cables using new technologies. Important Italian, French, German and Japanese companies, among others, have already asked to take part.

CESI is defining the new programs for the coming months to test HVDC station components such as valve stacks and accessories for cable systems. With the Type Test Certificate issued by CESI, manufacturers of these systems can have access to international TSO tenders with the awareness that they are recognised, through independent and accredited laboratories, as being among those qualified in the sector.

The decision to place this laboratory in Mannheim did not happen by chance. In fact, Baden-Württemberg's location in the centre of Europe is strategic for transport and services, but the region is also one of the areas identified to have one of the three important HVDC corridors that Germany is creating for the transfer of bulk renewable energy from the wind farms of Northern Europe to the central and southern regions.

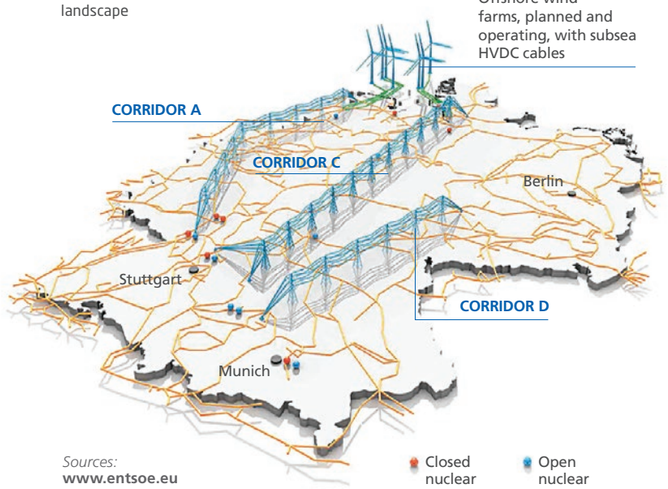
points and their essential characteristics. The final stage is the planning approval, which consists of public discussion and the approval of plans submitted by the TSO that define the specific routes of the corridors and possible alternatives.

THE GERMAN NETWORK WILL HAVE TO DEVELOP ACCORDING TO THE PRINCIPLE OF MAXIMUM EFFICIENCY AND MINIMAL ENVIRONMENTAL IMPACT

The first step in the German strategy is therefore to define the current scenario so as to determine as precisely as possible what the real energy demand will be in Germany over the next decade. The network will have to develop according to the principle of maximum efficiency and minimal environmental impact. It is necessary, therefore, to realise only those lines that are deemed necessary to support the expected energy load.

President Homann, in the above mentioned conference, said: "Thus far, expansion of renewable energy generation has been stimulated by a generous feed-in tariff system without taking into consideration the effects on the distribution and transmission grids. In future, it will be imperative that the pace of renewable growth matches the expansion of the networks. Otherwise, the progress made with regard to renewable generation capacity will come to nothing as the existing networks will not be able to take the generated electricity on board."

Three separate hvdc corridors will redefine the German infrastructural landscape



Sources:
www.entsoe.eu

The focus on a proper assessment of the energy demand was also emphasised in the interview the Authority gave to EJ: "The Network Development Planning is a continuous process done yearly. This allows the underlying forecasts to adapt to changes and new facts. The Bundesnetzagentur only confirms those lines that are essential and sufficiently robust to confront scenario changes. Even just a slight change in economic growth in the underlying assumptions, with constant demand, would require a substantial progress of energy efficiency and energy-saving technologies and applications. Particularly with regard to mobility and heat generation, we expect electric power to replace fossil fuels in order to reduce greenhouse gas emissions and hence compensate cuts in other areas."

Three separate HVDC corridors that will redefine the German infrastructural landscape have been approved and confirmed by the legislature through the Network Development Plan. "Currently we are now between steps 3 and 4 regarding all three projects", the German Authority told EJ. "As of now, none of the transmission system operators has filed a proposal for determining the path corridor pursuant to the Bundesfachplanung. We expect them to come."

The harmonization of the German transmission network in alternating current technology and the development of projects for innovative direct current corridors still has many aspects that must be defined both from the point of view of technology and design. All this new technological equipment, of course, first must go through a series of stringent tests to ensure absolute reliability and performance even under electric, mechanical and environmental "stress" conditions.

Will Germany manage to modernise central Europe's transmission network? The ambitious project of superimposed grids will certainly provide us with a new model for technological innovation, but also of innovative management of transmission and subtransmission networks that should push EU countries to move towards for an ever-increasing integration of European energy policies.

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| FACE TO FACE |

Saudi Arabia: a soaring plan for growth

Interview with Ahmed H. Al-Mubarak, Planning Consultant SEC,
and Gianluca Marini, Director Consulting, Solutions & Services Division CESI

THE EXPECTED DEMAND FOR ELECTRICITY IN THE KINGDOM IS LIKELY TO ALMOST TRIPLE IN 2032. TO MEET A SIGNIFICANT SHARE OF THIS GROWING DEMAND, SAUDI ARABIA IS DETERMINED TO DIVERSIFY ITS ENERGY SOURCES, REDUCE ITS DEPENDENCE ON HYDROCARBONS AND COMPLETELY REDEFINE ITS ENERGY MIX. TO GET TO THIS GOAL, RENEWABLE ENERGY IS KEY AND THE KINGDOM IS READY TO CHANGE ITS ENERGY PROFILE.

Ahmed H. Al-Mubarak

Gianluca Marini

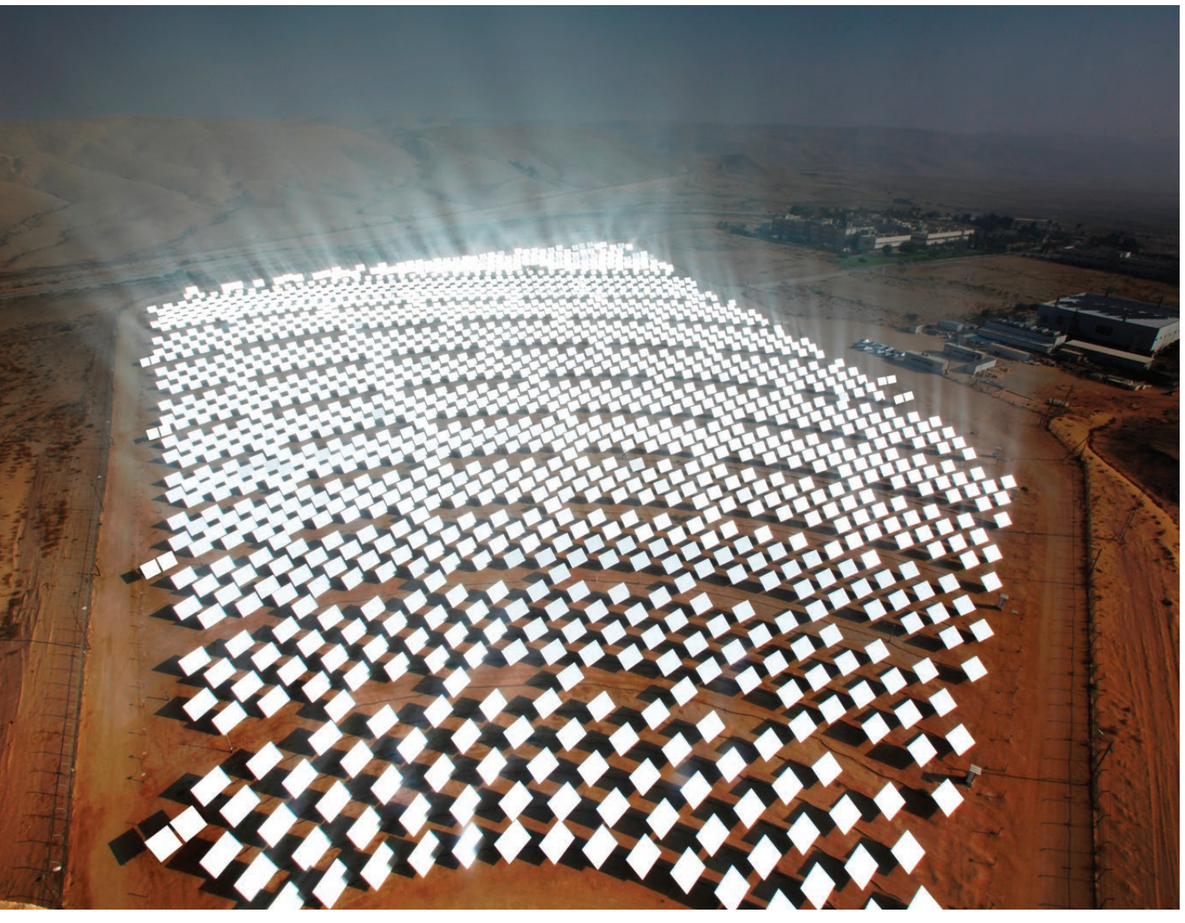
Energy Journal
Energy consumption in the Kingdom of Saudi Arabia is witnessing unprecedented growth. Data indicate an increasing demand for industrial consumption, but also private consumption exceeds every record in the area. How does the Kingdom intend to face this growth?

Ahmed H. Al-Mubarak
In Saudi Arabia, the increase in energy consumption has been driven mainly by rapid social and economic development. In 2012, the industry growth was about 7,5%, and forecast between 2013 and 2017 is about 5,6%. As you stated, residential consumption registered a boom, also due to growing population. Moreover, we are the third largest water consuming country in the world with an average consumption reaching 280 litres per day per capita.
The expected demand for electricity in the Kingdom is likely to almost triple from 45 GW in 2012 to 120 GW in 2032. Unless alternative energy sources and energy conservation measures are implemented, the overall demand for fossil fuels is estimated to grow from 3.4 million barrels oil, equivalent a day to 8 million barrels oil equivalent a day in 2032. For this reason, the Kingdom is building an energy program to meet a significant share of this growing demand.
Saudi Arabia will utilise a balanced mix of economically feasible and technically practical atomic and renewable energy in a sustainable way to generate power that enables preservation of the Kingdom's resources of oil and gas well into the future. This is almost like a revolution for the country and all the infrastructural system must rapidly change to profit by this new situation.

Gianluca Marini
From my point of view, Saudi Arabia's energy strategy is absolutely farsighted: they are overhauling their energy profile. I have no doubt they will hit the target.
On the contrary, the abundance of fossil and renewable energy they possess makes it unnatural to think about energy saving or energy efficiency. Even more difficult to believe that, Saudi Arabia is investing also in this sector. The measures taken until now resulted in a household energy saving of up to 50%. Considering specific environmental condition in the area, results can be really significant: air conditioning, for example, represents the 70% of the energy used by buildings and accounts for half of the total electricity consumption in the Kingdom.

SAUDI ARABIA IS RECOGNISING ITS FUNDAMENTAL POSITION AS A RESPECTED KEY SUPPLIER OF ENERGY GLOBALLY, WHILE ALSO ENSURING THE KINGDOM'S LONG-TERM PROSPERITY AND ENERGY SECURITY

In Europe and U.S.A. these are fundamental themes and both economies developed a well structured energy efficiency policy, defining challenging target to 2020 and to 2050. Saudi Arabia will probably soon develop an efficiency policy, which will be equally ambitious.



Saudi Arabia

Electricity demand
45 GW > 2012
120 GW > 2032

Renewables capacity
24 GW > 2020
54 GW > 2032

Solar power capacity
12 MW > 2012
41,000 MW > 2034

Sources: **K.A. CARE**

EJ
A revolution is occurring in the energy sector and the geopolitical scenario is deeply changing. We could talk about the shale gas revolution in the US, China solar panel exports or the new entrance as market competitors of countries such as Brazil, India, Africa. How do you expect Saudi Arabia's and the Middle East's role to change in this context?

A. H. Al-Mubarak
Saudi Arabia is determined to diversify its energy sources and reduce its dependence on hydrocarbons. The Kingdom output capacity is today about 12.5 million barrels a day, but domestic oil consumption is rising quickly and may start to cut into the amount of energy available for export. That's why renewable energy is absolutely necessary for Saudi Arabia which plans to redefine its energy mix totally. We aim to install 24 GW of renewable power capacity in 2020, but the final target is 54 GW in 2032. Following this road map Saudi Arabia will become the world's main producer of renewable electricity. Our solar power capacity, today, is 12 MW. But we are working for a huge jump forward: the country has plans to install 41,000 MW of solar power capacity generation over the next 20 years.

In so doing, Saudi Arabia is recognising its fundamental position as a respected key supplier of energy globally, while also ensuring the long term prosperity and energy security of the Kingdom. We have long term strategic plans on renewable energy. We think the Kingdom could also soon become solar electricity exporter to Europe via North Africa and Italy or Spain. The potential is about export up to 10 GW.

G. Marini
There are important economic reasons for this strategic choice: nowadays solar is a very cheap source of electricity.
First of all, prices for silicon based solar modules have fallen from 3,5 $ to less than 80 cents per watt, last year. For a country that currently burns oil that it could export, switching crude from the domestic market to the export market would increase potential Saudi export revenue. Acting as an electricity exporter toward Europe is certainly an ambitious plan. The link is technically feasible, financing is available, but hitting the target is surely difficult.

The Saudi Arabia project is just one of the several initiatives promoted from different actors having the Mediterranean area as central focus: we could talk about Desertec (in which CESI is directly involved), Res4Med, Medgrid and many others. They all mean to interconnect North Africa, Middle East and Europe, thus underlining the strategic importance of this area.

THE KINGDOM CAN BECOME AN EXPORTER OF SOLAR-GENERATED ELECTRICITY TO EUROPE VIA NORTH AFRICA AND ITALY OR SPAIN

EJ
Totally reshaping the energy system will require big changes in infrastructures, what are the strategic objectives in this area?

A. H. Al-Mubarak
In 2008, we promoted a 10 year investment plan for electricity infrastructure (2008 – 2018); the plan led to significant activity in the energy sector. We are now going far beyond: another 30 GW will be added to the currently estimated capacity by the 2020.

This unprecedented and rapid growth in renewables has to be correctly managed. There are different orders of problems. First of all we need to hugely empower the Kingdom's electricity grid, by building new smart grid and HVDC grid. Then we must provide the system with advanced measurement technology for forecasting weather and for monitoring energy transmission. Government spending in infrastructure projects is set to touch 266 billion in 2013. Public spending is set to increase by 15 percent from 2012

THERE ARE MANY ADVANTAGES TO INTERCONNECTING ELECTRIC POWER GRIDS OF SEVERAL COUNTRIES. THAT'S WHY SAUDI ARABIA HAS ALREADY SIGNED VERY IMPORTANT AGREEMENTS WITH OTHER STATES IN THE REGION

G. Marini
The main goal is certainly the modernisation of transmission and distribution grid, which must achieve higher efficiency standards.
CESI supports the Electricity and Co-Generation Regulatory Authority (ECRA) in shaping and developing a strategic plan for introducing smart grids in the country.

The plan previews 3 different operating levels: introducing renewable power generation, building up grid reliability and service performances, developing demand-side management policy and energy efficiency policy. CESI is working with SEC to develop detailed technical specifications for a High Voltage Direct Current (HVDC) power transmission interconnector between Riyadh and Jeddah covering the central and western regions in the Kingdom of Saudi Arabia.
The new 800 km HDVC link will not only increase the power generation capacity of local networks and improve the reliability of energy transmission, but also provide a reliable back up energy supply in emergency situations.

EJ
Saudi Arabia has a leading role in the Middle East. The revolution you are undertaking will certainly have consequences on other countries in the Middle East. Will your Renewables plan involve them directly?

A. H. Al-Mubarak
There are multiple advantages to be gained from interconnecting the electric power grids of several countries.
That's why Saudi Arabia has already signed very important agreements with other countries in the area. The newest is the partnership with Egypt. As you may know, these two countries produce about 92% from the power energy produced in the rest of Arab countries. The agreement concerns the linkage of the two national electricity grids; the project will allow power trading between the two countries. We will share the cost of the 3,000 megawatt HVDC interconnection which includes a20 km undersea transmission cable. The linkage is expected to take 24-30 months to complete. The project will effectively lead to linking the power grids of 14 Arab countries including the six member of Gulf Cooperation Council. The project is to be finalized by 2017

G. Marini
Egypt is part of another important project connecting all 20 members of the Arab League. CESI Middle East has been selected by the Arab Fund for Economic and Social Development (AFESD) to undertake a feasibility study to determine the best options for electrical and gas interconnections scenario to create a single energy market for 20 Arab countries by 2030.

The main purpose of the AFESD project is to establish a strategy and master plan for further developments in the trade of electricity and gas among the Arab countries and to determine the trade offs between export of electricity and or natural gas.

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| IDEAS & VISION |

Protecting centuries of history

Paolo Stigliano, Head of Structural & Civil Engineering
CESI-ISMES Engineering & Environment Division

To the left: the Leaning Tower of Pisa

ITALY POSSESSES AN ARTISTIC AND CULTURAL HERITAGE OF ABSOLUTE PREEMINENCE IN THE WORLD. UNFORTUNATELY, BY ITS VERY NATURE, THIS HERITAGE INEVITABLY DETERIORATES WITH THE PASSING OF TIME. CONTINUOUS MONITORING SYSTEMS ARE THE MOST EFFECTIVE SOLUTIONS TO ENSURE PRESERVATION OF SUCH AN INVALUABLE HERITAGE.

Italy has more UNESCO World Heritage sites than any other country in the world (49 of the 981 sites are in Italy). Paradoxically, however, it is the abundance of this heritage, the fact that is so widespread and not only in the famous cities of art but also in the small provincial towns, that there is the risk of losing the perception of its uniqueness and value.

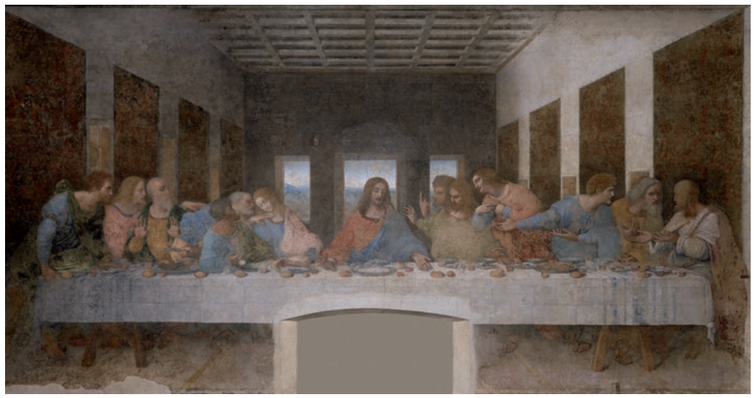
This priceless heritage bestows upon Italy very important direct and indirect economic benefits. But it is a heritage that is literally crumbling before the eyes of its admirers. Time coupled with the acid rain, wind, and pollution lead to its increasingly rapid deterioration.

It is possible to intervene, but to do so effectively while protecting the artistic and historic value of the works one must, as much as possible, respect the intrinsic characteristics of the sites subject to an intervention. For this reason, it is crucial to have a thorough knowledge of each element. Technology, often borrowed from totally different areas, can come to the rescue.

RESTORATION IS A COMPLEX SET OF INTELLECTUAL, CREATIVE AND TECHNICAL SKILLS THAT ARE DESIGNED TO ENSURE THE SURVIVAL OF HISTORIC BUILDINGS

What does it mean "to restore" a work of art?

The Venice Charter of 1964 defined architectural restoration and the restoration of monuments as the conservation of "historic and formal values of the monument" in the "respect of the antique substances and authentic documentation."



From the top:
San Marco Basilica in Venice, Santa Maria del Fiore in Florence and the Last Supper in Santa Maria delle Grazie in Milan.

Restoration is therefore a complex set of intellectual, creative and technical skills that are designed to ensure the survival of historic buildings, rescuing them from the threats of aging and aggressive agents, possibly bringing them back to their former splendor to preserve for posterity a history and culture (technology, manufacturing, scientific) that is slipping away.

This is a specialized field that requires a host of skills and experts. To develop and execute a restoration project one must have architects, geologists, engineers and chemists, but also archeologists, restoration historians, petrographers, seismologists and structural engineers as well as a whole series of technical specialists that are necessary to implement a variety of techniques and technologies that though developed for other fields and purposes give fundamental support to maintaining and restoring monuments.

TO DISPEL ANY DOUBT ABOUT THE STRUCTURAL STABILITY OF OLD BUILDINGS, TECHNIQUES HAVE BEEN DEVELOPED FOR SPECIFIC INVESTIGATIONS AIMED AT THESE TWO MAIN REQUIREMENTS STOPPING THE STRUCTURAL DECAY AND COPING WITH THE SEISMIC RISK

Ensuring the soundness of the structure

The first and most important aspect that should be taken into consideration when starting a restoration project is the structural stability of the building.

For old buildings, particularly ancient ones, it is natural to wonder whether their structural stability has eroded with the passage of time. To dispel any doubt on this point, techniques have been developed for specific investigations aimed at these two main requirements:

From the left:
Arch of Constantine in Rome and a cave church in Cappadocia

stopping the structural decay and coping with the seismic risk. Some of the techniques used are derived from those experimented on reinforced concrete buildings – for example for the control of dams, rock masses and tunnels – while others are the result of independent research and development.

The analysis of the structural behaviour takes place in two stages:
a) an exploratory phase, aimed reconstructing the history of the building and the techniques used in its construction,
b) a diagnostic phase to determine the characteristics of the foundations, the state of preservation of the building, the static scheme, and the strength and durability of the materials.

In the first phase the restoration team collects documentary material and makes direct observations with the geometric survey of the building.
The experts proceed with the adjustments made to the structural schematics, with the analysis of materials and construction technologies, with a survey of the state of conservation. At the end of the first phase it is already possible to characterize the static behaviour of the building and to set up a test to access the stability.

This framework is further examined in the second phase, which looks at the diagnostics. To better understand the technology used in the construction and the geometry of the parts that cannot be directly inspected – for example the foundations – one makes use of drilling, exploration probes, radar, and sonic surveys. Sclerometer tests as well as chemical and mineral-petrographic analysis are instead used to assess the state of conservation of the material.

Monitoring: before, during and after restoration

The monitoring phase merits special attention. This term refers to a series of interventions that enable you to understand the structural behaviour of the structure being examined.

| ISMES-CESI, the value of experience |

For ISMES, CESI's Division specialized in civil structures and environmental monitoring, the protection of cultural heritage is one of its most passionate assignments. It's a love and passion story that begins in the 1950s, with a speech at the Mole Antonelliana in Turin, and in the decades since has meant installing and maintaining monitoring systems to protect some of the most important Italian and international sites. Among these it is worth mentioning Leonardo da Vinci's Last Supper in Santa Maria delle Grazie in Milan, the San Marco Basilica and Santo Stefano bell tower in Venice, Santa Maria del Fiore and bell tower of Badia Fiorentina in Florence, the Temple of Romulus and the Arch of Constantine in Rome, the cathedrals of Milan and Orvieto, the San Francesco church and La Verna Sanctuary in Arezzo, the Leaning Tower of Pisa, the Sant'Eustorgio Cloisters in Milan, the cathedral and towers of Pavia, the monastic complex of San Fruttuoso in Camogli, the Catullo caves in Sirmione, the Latomie of Syracuse, the Luxor temple in Egypt, cave churches in Cappadocia, the cathedral and the National Palace of Mexico City.

Below:
Mole Antonelliana in Turin

| ISMES-CESI approach to monitoring |

In carrying out the monitoring of structural works, ISMES-CESI applies a "distributed" model.
A central control unit is connected to peripheral units that govern the individual sensors used to measure the variables being monitored.
Compared with centralized systems, distributed systems provide better measurement accuracy, improved signal/noise ratio and a significant reduction of costs.
The structural monitoring system may be associated with a numerical control model.
In particular, the analysis of numerical models are used to:

- check the static condition of the structure and its foundation,
- forecast the possibility that new cracks will emerge in the structure in the absence of moves to rehabilitate and reinforce it,
- verify the structural safety of the structure during the execution of the restoration work,
- calculate the stress of the structure after the restoration is completed.

Below:
the Luxor temple in Egypt

The monitoring begins before the intervention phase, continues during the consolidation of the structure – to allow one to work safely – and it is vital that it continues once the project is finished.

CONTINUOUS MONITORING OF THE CHANGES THAT OCCUR OVER TIME TO AN ARCHITECTURAL STRUCTURE, OR ART WORK, IS KEY TO PREVENT CRITICAL PROBLEMS

The monitoring systems installed on the structures typically find static characteristics: absolute repositioning, changes in the size of cracks, changes in the state of stress in the main structural elements effect characteristics, changes in temperature, wind load, and yielding of the foundation cause characteristics.

To check the quality of the interventions and strengthen the structure, some of the characterization tests performed during the surveys are repeated. Finally, after the intervention tests it is always advisable to check the most important variables of the static structure.
The monitoring system installed at the time of the initial survey, and later adjusted to check the interventions made during the restoration, can again be modified and simplified for the periodic testing of the structural behaviour.

Keeping under observation, through monitoring , the changes that occur over time to an architectural structure or art work is paramount to prevent critical problems and intervene in a timely manner should they occur.

The professionalism, experience and advanced techniques we have today are a key tool for protecting the priceless artistic and cultural heritage that humanity has expressed over the millennia.

From the left:
the cathedrals of Milan and Mexico City

| REVIEW |

Truths we must tell ourselves to manage climate change

Robert Socolow, Vanderbilt Law Review

The earth revolves around the sun. Man descended from monkeys. These two truths, which are at the foundation of modern scientific knowledge, appear so obvious that it is difficult to understand the radical nature of the ostracism they were subjected to when they were first presented.

Yet, says Robert Socolow , professor of mechanical and aerospace engineering at Princeton University, in his paper "Truths We Must Tell Ourselves to Manage Climate Change," we are not so different and the resistance today that opposes truths that are just as uncomfortable – but equally evident in the eyes of the scientific community – is just as strong. What we are unable to accept is that as humans we can really affect and change the planet's equilibrium. The truth that we do not want to hear is above all that climate change is due to human activity.

SOCOLOW CONFRONTS TECHNICAL-SCIENTIFIC ISSUES AS WELL AS PHILOSOPHICAL AND MORAL QUESTIONS

This inability to accept an obvious truth – which is backed by scientific evidence accepted by the overwhelming majority of scientists – makes it extremely difficult to publicize climate change, talk about the topic and all its implications and develop strategies to address the challenge it presents. This has nothing to do with the complexity of the issue, says Socolow, and it is rather a question of approach. For this reason, the goal that climatologists must set is to renew the way they have so far addressed the issue publicly and start over from the beginning using new methods.

Hitting the "restart button" is indeed the goal Socolow sets for himself in this short essay in which he is mainly addressing his colleagues and urging them to "tell the truth to confront climate change."

With an enjoyable writing style that is coupled with rigid clarity in thought and language, Socolow approaches technical-scientific issues – supply and demand of energy, population growth, nuclear power, geoengineering, CCS, emissions – as well as philosophical and moral questions. At the same time he invites us to reflect on the theme of "planetary identity" or membership of the planet. The idea is to move above and beyond all borders and every "tribal conception."

And that is not all. Socolow's jab goes so far as to call for a new academic discipline – "Destiny Studies" or the art and science of looking ahead. While in every other field of knowledge we have made tremendous progress, we cannot say the same about the art and science of looking ahead, says the Princeton University professor. This is not about predicting the future, but instead is about being able "to deal adequately with the values at stake in decisions with long time horizons, of which climate change is just one example."

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WIN Electrotech Exibition 2014

Date > 19th - 22nd of March 2014
Venue > Istanbul, Turkey
http://www.win-fair.com/en/electrotech.html

CESI participated at the World of Industry WIN Electrotech Exhibition 2014. A choice that confirms its strong commitment in the Eurasian regional electricity market.

LatAm-Europe: National Experiences, Common Languages and Future Trends

Date > 9th - 11th of April 2014
Venue > Rio de Janeiro, Brazil

CESI has been invited to hold a speech during “LatAm-Europe: National Experiences, Common Languages and Future Trends”, an International Workshop organized by ABRADEE, the Italian Ministry of External Affairs and Enel Foundation for sharing regulatory practices and perspectives.

AEIT Workshop

Date > 29th of May 2014
Venue > Milan, Italy
http://www.aeit.it/r01.5/cale01.php

CESI’s Auditorium in Milan will host the AEIT workshop on HVDC. Founded in 1897, AEIT is one of the oldest italian association of companies operating in electricity and electronic sectors.

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